DIRECT TESTIMONY OF
ERIC H. BELL, P.E.
ON BEHALF OF
DOMINION ENERGY SOUTH CAROLINA, INC.
DOCKET NO. 2019-184-E

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND OCCUPATION.

A. My name is Eric H. Bell. My business address is 220 Operation Way, Cayce, South Carolina. I am Manager of Economic Resources Commitment for Dominion Energy South Carolina, Inc. ("DESC" or the "Company").[1]

Q. STATE BRIEFLY YOUR EDUCATION, BACKGROUND, AND EXPERIENCE.

A. I am a graduate of the University of Texas with a Bachelor of Science degree in Electrical Engineering and am licensed in South Carolina as a Professional Engineer. Following graduation, I served in the United States Navy as a Nuclear Submarine Officer. In 1994, I began my career with SCE&G as Assistant Plant

[1] South Carolina Electric & Gas Company ("SCE&G") changed its name to Dominion Energy South Carolina, Inc. in April 2019, as a result of the acquisition of SCANA Corporation by Dominion Energy, Inc. For consistency, I use "DESC" to refer to the Company both before and after this name change.

Engineer and in 1997 was promoted to Operations Planner for the Company. From 2001 to 2008, I was responsible for the Company's economic resource commitment efforts and, in 2008, I assumed my current role as Manager of Economic Resource Commitment. In this position, I am responsible for managing and optimizing generation fleet operations to provide reliable reasonably-priced energy to DESC customers. Among other things, my responsibilities include participating in fuel purchasing decisions, unit commitment, and the coordination of activities with power marketing, transmission system control, maintenance scheduling, and natural gas supply.

Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT WITNESS BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA ("COMMISSION")?

A. No, this is my first time appearing before the Commission.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to discuss the actual operational experience of the Company related to managing energy supply including the photovoltaic ("PV") solar generation facilities interconnected with DESC's system. I also discuss the reference data and other inputs derived from this operational experience, which the Company provided to Navigant Consulting, Inc. ("Navigant") in connection with the PV solar generation facility impact study sponsored by Company witness

Dr. Matthew W. Tanner. Finally, I discuss the Company's review of the Navigant simulations.

Q. WHAT ARE THE OPERATING CHARACTERISTICS OF UTILITY-SCALE SOLAR GENERATION FACILITIES?

A. Because PV solar panels convert light directly into electricity, the amount of sunlight on the panels dictates the electrical output of each facility. Uncontrollable factors including time of day and local weather conditions also influence the amount of energy that can be produced. This means that PV solar produces electricity independently of customers' demand for energy. In general, PV solar facilities begin producing some energy just after sunrise. Then their output increases for about 3 or 4 hours to anywhere between less than 10% of rated capability and 100% depending upon cloud cover. Recent data shows that output averages about 74% of rated capability by around 11:00 A.M. In addition to the more predictable ramps at the beginning and end of the day, unpredictable minute-to-minute variability occurs throughout the day. This is unlike dispatchable generation, such as those from natural gas fired generating facilities, that is much more controlled and can be adjusted to produce energy when and as needed. Just as importantly, energy from dispatchable generation facilities can be reduced when it is not needed.

Q. DOES THE COMPANY HAVE CHARTS FROM PAST OPERATING RESULTS THAT VISUALLY DEMONSTRATE THE VARIABILITY OF UTILITY-SCALE SOLAR GENERATION?

A. Yes. To visually demonstrate this variability, Charts 1 through 6 below show actual examples of production profiles of the aggregated output of utility-scale solar generation on DESC's system earlier this year. Each chart contains a display of 1-minute data from 6 A.M. to 8 P.M. on the actual day noted on the chart. The chart scale for the utility-scale aggregated power output on the left axis is in megawatts. Notice that the maximum solar generation that was in service for production changes over time.

Chart 1 shows data from a very sunny summer day and energy production is expectedly high. Starting about 7 A.M., solar generation can approach full output in less than 3 to 4 hours, which is fairly characterized as an uncontrolled ramp.

Chart 1

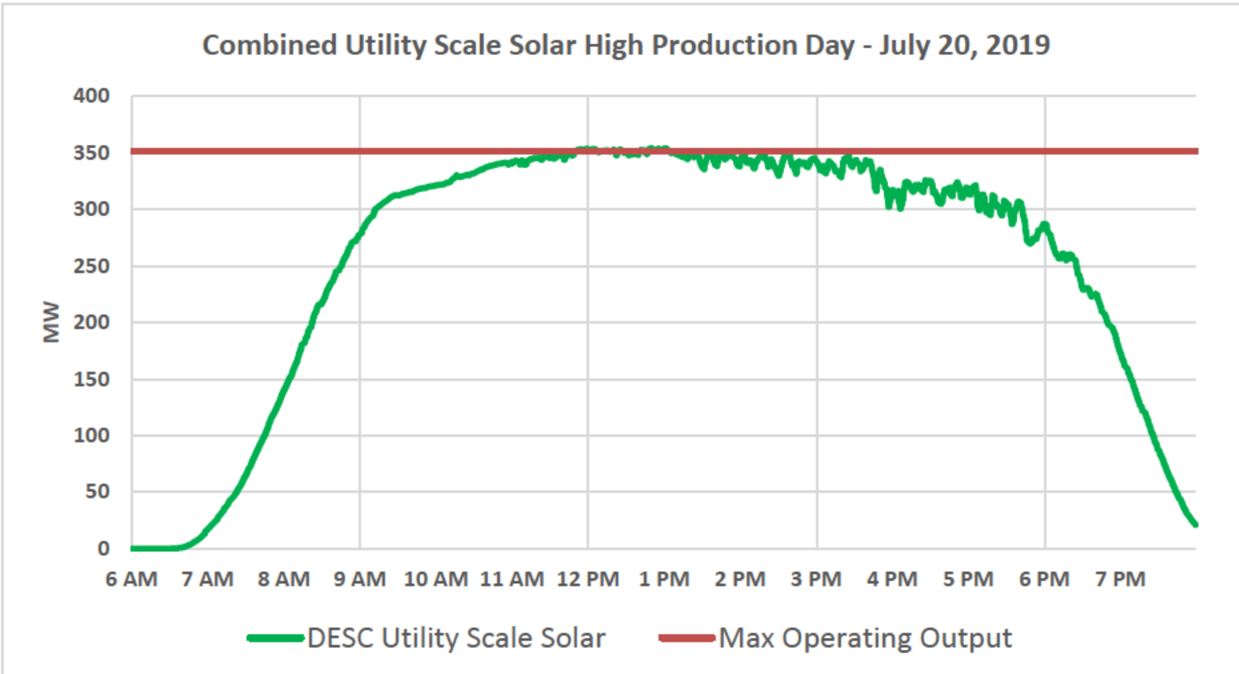


Chart 2 displays data from a high production day in the winter with a more aggressive ramping of generation.

Chart 2

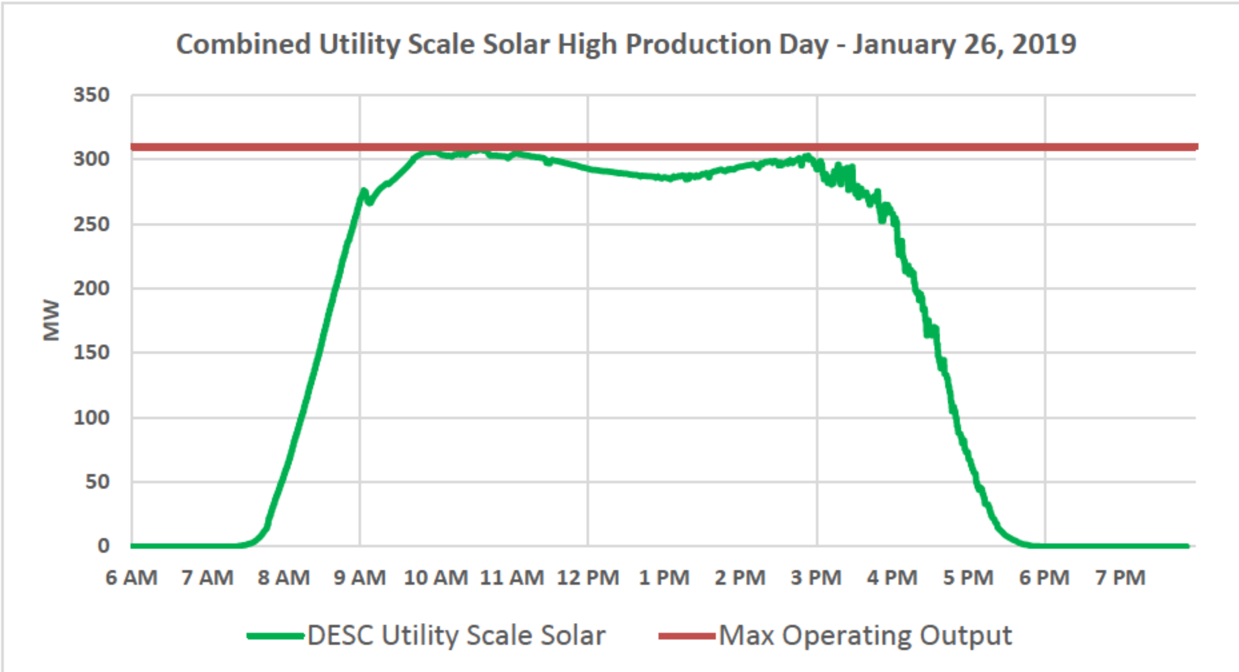


Chart 3 below shows aggregated data from a partly-cloudy day and shows somewhat reduced production due to cloud cover. The saw-tooth pattern provides challenges to the system because this energy supply is constantly changing, requiring the output of other system generators to be adjusted constantly to maintain the system in balance.

Chart 3

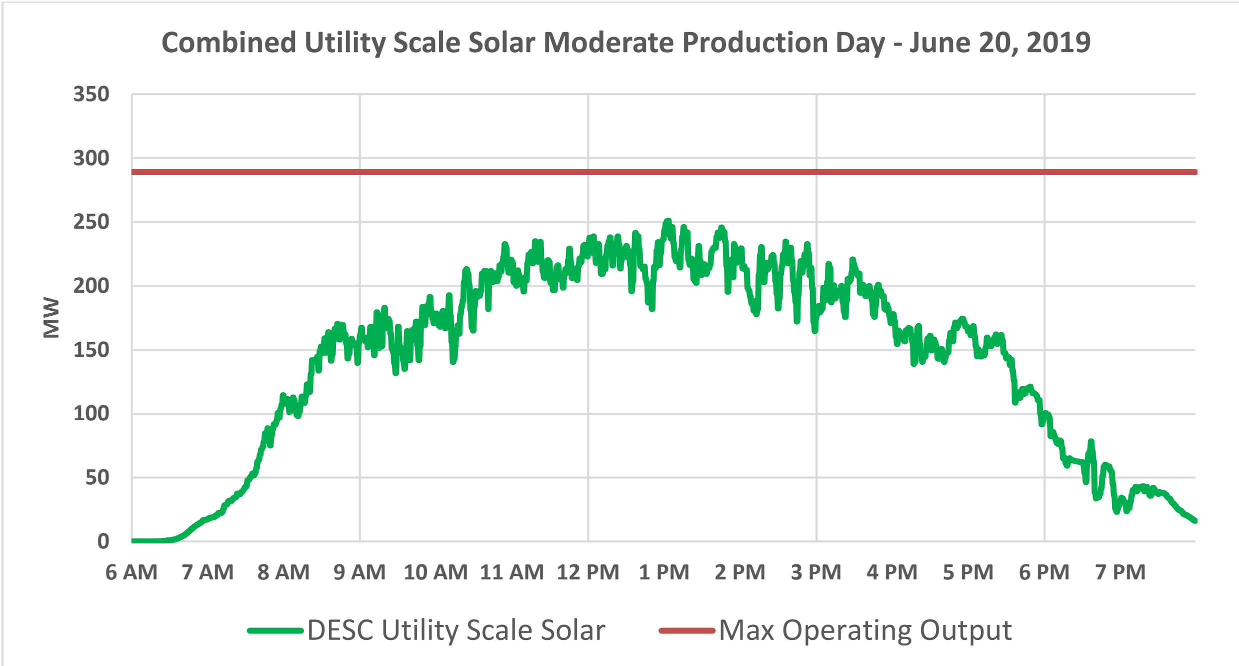


Chart 4 shows aggregated output on a cloudy day where energy production is low. On the low production days, the Company's generation capacity must deliver greater output to meet the demands for energy of our customers with a reduced contribution from solar.

Chart 4

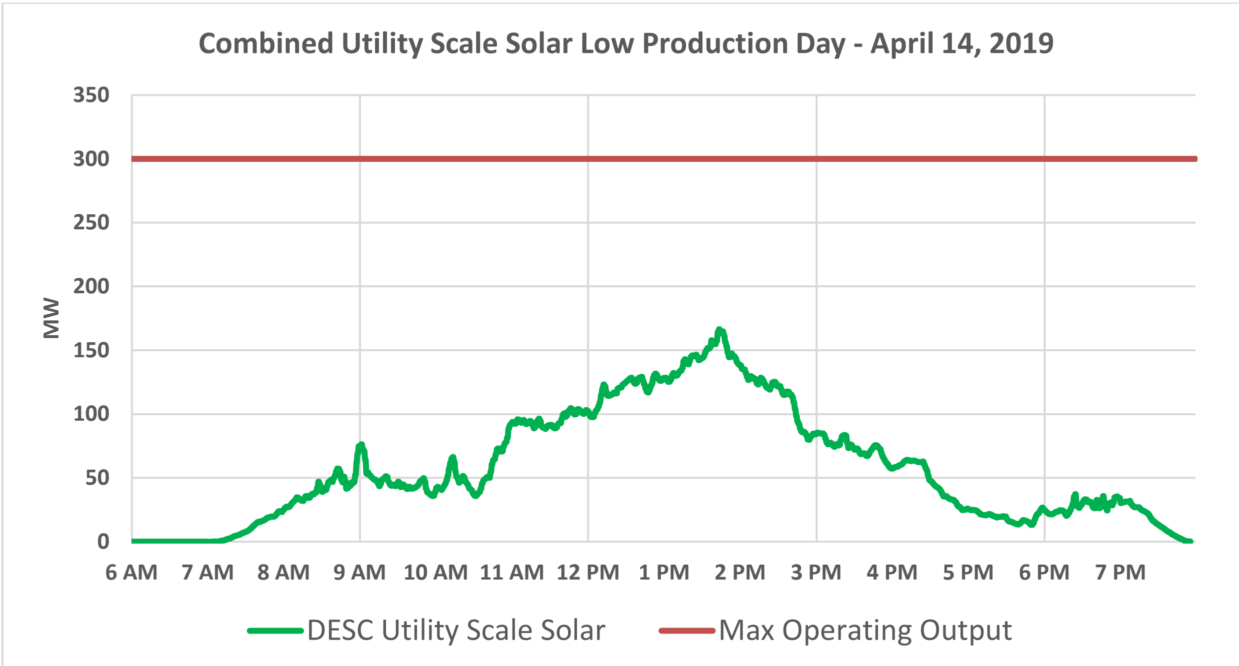


Chart 5 shows varying output during a day that goes from partly-cloudy to cloudy to partly-cloudy with utility-scale solar taking two to four hours to ramp up or down. These unplanned drops and increases, reflecting changes in generation of hundreds of megawatts, increases the balancing ramps required of dispatchable generators.

Chart 5

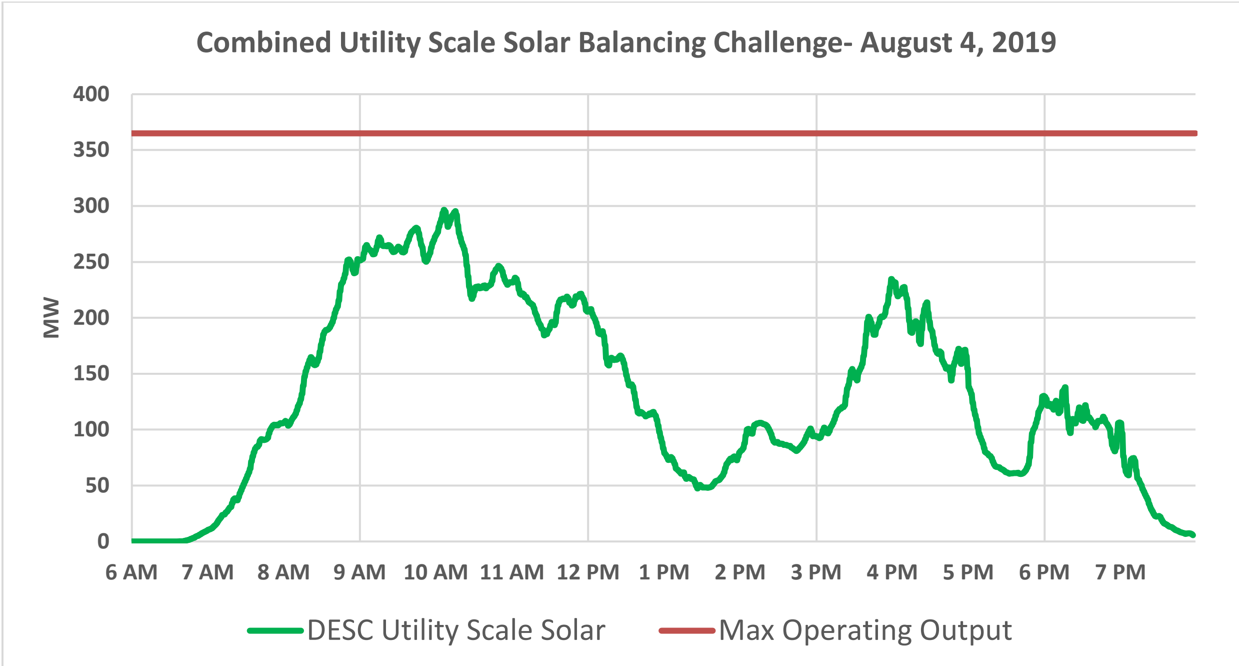
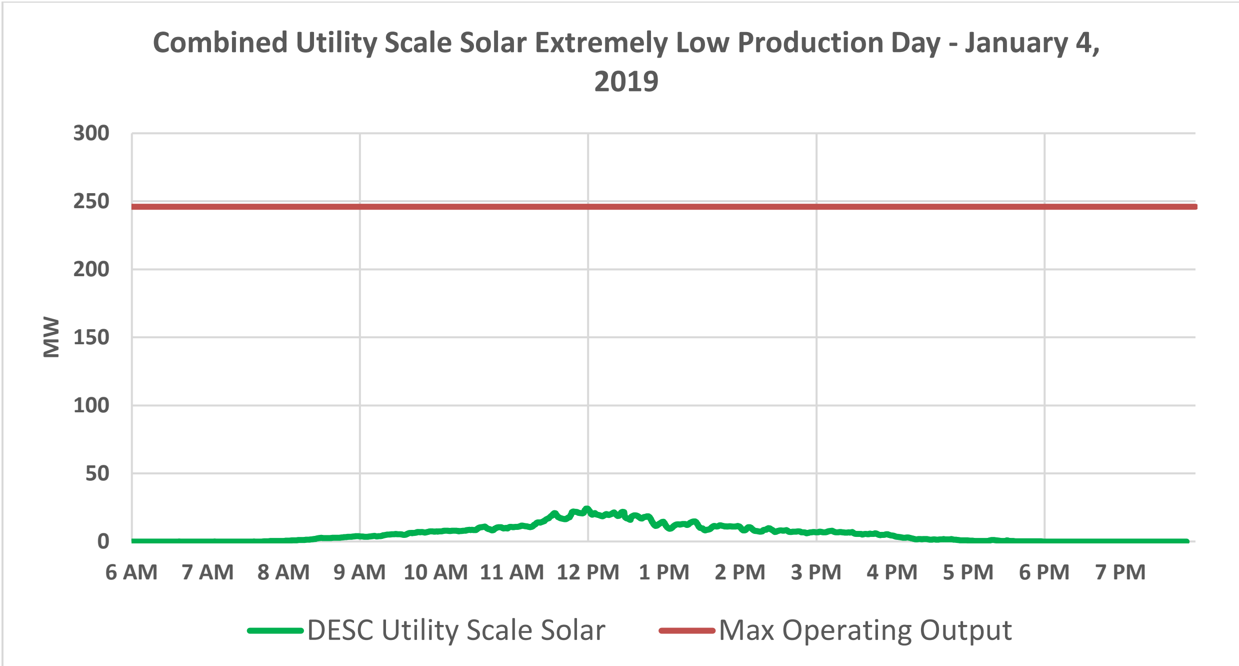


Chart 6 also shows data from an actual day earlier this year where 246 MWs of operating solar facilities produced a peak output of only 18.6 MW. That output was just 50% of the forecasted output on this mild and very cloudy day and was only a fraction of median output.

Chart 6



Q. HAS THE COMPANY EXPERIENCED A RECENT INCREASE IN THE AMOUNT OF SOLAR FACILITIES INTERCONNECTED WITH ITS SYSTEM?

A. Yes. The Company has recently experienced a significant increase in PV generator interconnection interest especially in the most recent two-year period. A 2 MW rooftop installation and an approximately 7 MW of Distributed Energy Resource ("DER") utility-scale installation were the only utility-scale PV solar generators in the DESC service territory before 2017. By December 31, 2018, approximately 433 MW of PV solar generation was interconnected to the DESC system. Those facilities include approximately 63 MW in residential behind-the-meter systems, 6 MW in commercial behind-the-meter systems, 19 MW in commercial in-front-of-the-meter systems, and 345 MW in "utility-scale" solar (14 MW is community solar and 331 MW is other utility scale to include DER utility scale facilities). From January 1, 2019 to August 22, 2019, another 6 facilities have begun commercial operation for an additional 113 MW. Combined, as of August 2019, DESC has a total of 511 MW of solar generation in commercial operations on its system.

Q. ARE THERE ADDITIONAL SOLAR FACILITIES THAT DESC EXPECTS TO BE INTERCONNECTED TO ITS SYSTEM IN THE NEAR FUTURE?

A. Yes. In addition to the facilities already interconnected and providing power to the DESC system, another 12 non-DER solar facilities have executed agreements with the Company to provide additional solar power to DESC's system. Each of these facilities is expected to enter commercial operation between now and the end of 2020. When constructed and interconnected, these additional facilities will add approximately 624 MW of additional utility-scale solar generation to the Company's system. Following these interconnections and along with the projected growth of 16 MW in residential and commercial behind-the-meter systems, DESC expects to have a total of 1,152 MW of solar facilities interconnected with its system by the end of 2020.

Q. DOES THIS AMOUNT OF SOLAR GENERATION CREATE ANY CHALLENGES IN SAFELY AND RELIABLY OPERATING DESC'S SYSTEM IN COMPLIANCE WITH REGULATORY REQUIREMENTS?

A. Yes. As stated earlier in this testimony, solar generation is a variable energy resource, meaning that it cannot be dispatched or predicted exactly. Normally, dispatchable generation is added in economic merit order as system load increases and removed as load decreases. By comparison, solar generation is a product of uncontrollable factors such as available sunlight and cloud cover, and a solar facility's output is not necessarily responsive to system needs. Because of this variability in generation, DESC must make operational adjustments to follow the energy generated by solar facilities and to maintain sufficient reserve generation capability in order to meet system reliability requirements. In addition to being variable moment to moment, solar generation varies widely from the solar generation forecasts provided by solar operators, which also creates a need for reserves. It is anticipated that solar generation will eventually exceed DESC's ability to provide adequate reserves unless DESC maintains more hourly operating reserves or adds more quick start resources to its system. Unlike the owners of solar generating facilities, DESC has an obligation to balance generation to load and maintain reserves at all times as discussed further below.

Q. GIVEN THIS VARIABILITY, HOW DOES DESC PLAN FOR THE AMOUNT OF SOLAR GENERATION THAT IS PUT TO ITS SYSTEM ON A DAILY BASIS?

A. On a regular basis, both the solar generation owners and the Company forecast the expected amount of solar generation, taking into account anticipated weather conditions and the characteristics of the individual generating facilities. Because actual weather conditions can vary greatly from forecasts, projections of anticipated solar generation are much less reliable than those of other generating resources such as a natural gas or coal-fired generation facility. Some, but not all, of the forecasted solar generation can be expected with reasonable certainty; however, when the amount of solar energy actually generated does not meet the forecasted projections, the shortfall must be supplied by generation from another resource. The utility must be ready for the unexpected loss of solar generation well ahead of the contingency. Traditional types of generators cannot begin generating electricity immediately, but must be given adequate time to be brought on line and respond when called upon to fulfill unexpected shortfall. Although some types of smaller generators on DESC's system can start quickly from an offline standby condition, the amount of capacity they can supply is limited. DESC's larger generators need to be brought on line well ahead of the contingency.

Q. HOW DOES DESC PLAN FOR SUCH OCCURRENCES?

A. The Company is subject to requirements established by the North American Electric Reliability Corporation ("NERC") and the SERC Reliability Corporation. The Company also is a signatory to the VACAR (Virginia/Carolinas) Reserve Sharing Arrangement through which it maintains required reserve generation capability at all times in the event of a contingency—i.e., a reserve call from a neighboring utility, a sudden loss of generation such as when a generating facility is unable to generate electricity, or unexpected and higher demand on the Company's system. When a VACAR reserve sharing partner calls upon reserves or a DESC generator experiences a sudden unplanned forced outage, reserve capability is being "used," and does not need to be reestablished immediately under the terms of the VACAR Reserve Sharing Arrangement. However, when the territorial load exceeds forecast or non-dispatchable solar generation is not producing the expected level of electric generation, DESC must ensure that other generation is producing power to meet load, while making other generation supply available to maintain the reserve requirement. Under these circumstances, DESC must have generators available or online that are capable of quickly and reliably producing electricity so any sudden shortfall can be met.

Q. HOW ARE CONTINGENCY RESERVES SUPPLIED?

A. Contingency reserves must be supplied on demand within fifteen minutes and include spinning and non-spinning reserve requirements. Spinning reserves are provided by generators that already are online but not operating at full capacity and therefore can immediately generate additional electricity to serve the load. Non-spinning reserves may be supplied by both online and offline generators that can be fully loaded within fifteen minutes. The generators with the fastest response capability are quick-start internal combustion turbines ("ICTs"), some hydropower facilities, and pumped storage generators ("Pumped Storage"). Economical operation of ICTs normally has them offline in stand-by and supplying non-spinning reserve capability much like Saluda Hydro provides spinning and non-spinning reserves. In the future, both of those types of units will continue operating in the same way from the standby mode.

Q. HOW IS DESC ABLE TO INCREASE ITS AMOUNT OF AVAILABLE RESERVE CAPACITY?

A. The only way to increase reserves from ICTs and Saluda Hydro is to construct additional units. Reserves from quick starts and Saluda Hydro have been fully utilized for years, and no additional reserve value can be gained from those existing units. While Pumped Storage does supply spinning and non-spinning reserves, the optimal operation of Pumped Storage is dictated by economical limitations. Creating additional reserves by holding back Pumped Storage adds fuel costs in most circumstances because the output from higher cost generating units must be increased. In addition, the Company can increase its reserves by operating more coal and gas-fired baseload units. However, doing so may require DESC to operate its natural gas or coal-fired generating facilities under low load conditions or at an output level that is less efficient, i.e., more costly, than the optimum level for which they were designed. Thus, there is a cost to operating the generating units that provide these higher reserve levels, and those costs increase as more reserves are required.

Q. HAS THE COMPANY ATTEMPTED TO QUANTIFY THESE OPERATIONAL COSTS?

A. Yes. As further discussed by Company witness Dr. Matthew Tanner, DESC engaged Navigant to evaluate the operational and financial impact of serving DESC's customers with PV solar generation in addition to the Company-owned resources.

Q. IN PREPARATION FOR THIS STUDY, DID DESC PROVIDE NAVIGANT WITH OPERATIONAL DATA FROM THE COMPANY?

A. Yes. The Company provided Navigant with information concerning DESC's NERC/VACAR operating requirements, as well as input and reference data related to the PV solar generation facilities interconnected with DESC's system. The Company also provided Navigant with forecasts shown in Table 1 below.

Table 1

	Summer Peak (MW)	Winter Peak (MW)	Energy Sales (GWh)
2019	4,639	4,749	22,654
2020	4,688	4,792	22,828
2021	4,733	4,822	23,014
2022	4,772	4,860	23,153
2023	4,810	4,882	23,331
2024	4,835	4,921	23,461
2025	4,874	4,963	23,649
2026	4,919	5,007	23,879
2027	4,961	5,046	24,123
2028	5,003	5,085	24,353
2029	5,042	5,124	24,581
2030	5,084	5,166	24,807
2031	5,125	5,208	25,061
2032	5,168	5,248	25,310
2033	5,208	5,290	25,563

In addition, the Company provided Navigant with its current resource plan showing the need for additional capacity during the next fifteen years and identifying, on a preliminary basis, whether the need is for summer or winter capacity. The current resource plan is attached to the Direct Testimony of Company

Witness Mr. James Neely in Table 1 of Exhibit No. ___ (JWN-1). DESC also provided Navigant with the Company's peak seasonal demand, energy sales, and self-owned generation portfolio, as well as information concerning generator characteristics, including size in megawatts, fuel cost, efficiency, and operating flexibility. This information is included in the Company's 2019 IRP filed on February 8, 2019, in Docket No. 2019-9-E, which I incorporate herein by reference, and provides an accurate representation of the Company's dispatchable electric supply. Finally, the Company provided information concerning actual solar generation profiles from existing projects, existing solar PPAs, forward fuel prices, and natural gas pipeline contracts.

Q. DID THIS INFORMATION INCLUDE PROFILES OF SOLAR FACILITIES INTERCONNECTED WITH DESC'S SYSTEM?

A. Yes. The Company provided Navigant with hourly solar energy profiles from actual solar installations with energy production from five geographic areas in the DESC service territory. On the DESC system, the PV solar generation energy production profile is dominated by the utility scale single-axis tracker with panel capability in excess of the plant rating and inverter capability. On sunny days, this generating profile sharply increases from sunrise to nearly full load electrical output in less than 3 to 4 hours. PV solar output then stays at or near full load until about 3 to 4 hours before sunset, unless there is cloud cover. On partly cloudy days, the profile is extremely volatile and much less predictable. Cloudy days result in expectedly low generation output. Although this relationship is conceptually simple, the partly cloudy and cloudy days are the most difficult to forecast and can cause large deviations from the generating forecast. In all cases, the Company must anticipate and plan for significant variations from the forecast and, therefore, maintain adequate reserves to balance the load.

Q. PLEASE BRIEFLY DESCRIBE NAVIGANT'S CASE STUDIES.

A. In the Navigant study, each variation, or "case," simulates the introduction of more installed solar generation that supplies energy to DESC's system. In connection with the study, DESC provided Navigant with estimates of the amount of solar generation expected to be interconnected with its system by 2020. The original scope of the study was to include varying estimates of solar generation to displace fossil-fueled and hydro generation of 350 MW, 725 MW, and 1,050 MW. At the time the study was originally commissioned, these tranches were reasonable approximations of the amount of solar capacity expected to interconnect with DESC's system in each year through 2020.

By the time of the study update, DESC provided Navigant with updated information regarding the actual amount of solar generation on its system and expected to interconnect with its system pursuant to signed PPAs. Approximately 700 MW of those PPA's included the following language that contains the following VIC clause:

Seller shall be responsible for the payment of all charges that result from any change in any applicable law that occurs after the Effective Date that imposes new or additional (i) obligations on a Party to obtain or provide transmission service or ancillary services prior to the Delivery Point, or (ii) variable integration charges or imbalance costs, fees, penalties, or expenses, or provides benefits that, in the case of either clauses (i) or (ii), are imposed, assessed or credited by the transmission provider based on the impacts of energy generated by variable generation projects generally (collectively, the "Variable Integration Costs"). Seller shall be responsible for all Variable Integration Costs, irrespective of whether the Variable Integration Costs are assessed against Seller or Buyer and, to the extent any Variable Integration Costs are incurred by Buyer, Seller shall promptly reimburse Buyer for such Variable Integration Costs.

Due to the differences in the applicability of VIC charges to individual PPAs, the base case includes the first tranche of solar installations that do not contain the VIC clause. Navigant then focused on a single change case with the remaining signed PPAs that contain the VIC clause. As a result, the Navigant study analyzed the impact of the actual amount of solar interconnected prior to 2018 separately from utility-scale solar expected to be interconnected with its system by the end of 2020. Specifically, the base case and first tranche contains 336 MW of solar generation actually under construction and expected to be interconnected with DESC's system by the end of 2018 and the study change case has the additional 708 MW (1044 MW total) of solar generation expected to be interconnected by the end of 2020.

Q. HOW DO THE ESTIMATES OF SOLAR GENERATION USED IN THE STUDY COMPARE TO THE ACTUAL EXPERIENCE OF THE COMPANY AND ITS UPDATED FORECASTS?

A. The estimates used in the study are very similar, but less than, the actual amounts of utility scale solar generation interconnected to DESC's system by the end of 2018 and currently forecasted by the Company to be interconnected by the end of 2019 and 2020. Specifically, the cumulative nameplate facility rating of utility scale solar generation actually interconnected with the Company's system by the end of 2018 was approximately 310 MW. The total solar installed was approximately 434 MW as compared to the Navigant Baseline scenario of 336 MW. Finally, based upon the PPAs executed by potential solar owners/operators, DESC forecasts that approximately 1,048 MW (cumulative nameplate facility rating) of utility scale solar generation will be interconnected with its system by the end of 2020, as compared to the All Solar Case scenario of 1,044 MW.

When residential behind-the-meter systems, commercial behind-the-meter systems, and commercial in-front-of-the-meter systems are considered, the estimates used in the study are lower and more conservative than annual totals that are expected to reach 1,152 MW of generation capability by 2020.

Q. DID DESC REVIEW THE RESULTS OF NAVIGANT'S SIMULATION?

A. Yes. Navigant uses a modeling software known as PROMOD®, which is a production cost model that simulates the dispatch of generating units based upon theoretical operating scenarios. These models are used to analyze electricity system costs including how system costs change when aspects of those systems change. In order to verify that Navigant's simulations reflected DESC's actual operating experience, the Company's Economic Resource Commitment and Resource Planning departments reviewed the baseline scenario and recommended adjustments with respect to certain operating parameters and characteristics. As a result, the PROMOD® simulations reasonably reflect the actual operating characteristics of DESC's system.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.